

DOT/FAA/AR-96/125

Office of Aviation Research
Washington, D.C. 20591

Video Landing Parameter Survey—John F. Kennedy International Airport

Thomas DeFiore
Richard Micklos
Federal Aviation Administration
Airworthiness Assurance Research and Development Branch
William J. Hughes Technical Center
Atlantic City International Airport, NJ

July 1997

Final Report

This document is available to the U.S. public
through the National Technical Information
Service, Springfield, Virginia 22161.



U.S. Department of Transportation
Federal Aviation Administration

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof. The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the objective of this report.

1. Report No.

DOT/FAA/AR-96/125

4. Title and Subtitle

VIDEO LANDING PARA.
INTERNATIONAL AIRPORT

7. Author(s)

*Terence Barnes, Thomas E.

9. Performing Organization Name and Address

*Naval Air Warfare Center
Aircraft Division
Patuxent River, MD

12. Sponsoring Agency Name and Address

U.S. Department of Transportation
Federal Aviation Administration
Office of Aviation Research
Washington, DC 20591

15. Supplementary Notes

This video landing parameter survey was conducted by the Naval Air Warfare Center, Aeronautical Systems Division, Patuxent River, MD, under contract AAR-432.

16. Abstract

The Federal Aviation Administration has conducted initial surveys at high-capacity commercial airports around the world to determine aircraft and airports as they relate to landing parameters.

The initial parameter landing surveys were conducted using cameras temporarily installed on narrow-body, and 108 aircraft. The results presented include sink rate, distance from the runway to touchdown, and other parameters for most landings. Since the initial surveys were conducted without regard to aircraft type, these results are presented without regard to aircraft type.

Subsequent surveys have been conducted at additional airports; these results will be reported in future reports.

17. Key Words

Landing parameters, Sink rate, Roll, and Yaw angles and rates.

19. Security Classif. (of this report)

Unclassified

Form DOT F1700.7 (8-72)



EXECUTIVE SUMMARY

1 INTRODUCTION

2 SYSTEM DESCRIPTION

3 DISCUSSION

4 CONCLUSIONS

5 REFERENCES

APPENDICES

A—Statistical Data

B—Listing of

C—Landing Flights

**D—Accuracy
Aircraft**

Video Camera

MAA Landing

Average Main

Approach Spec

Histograms of

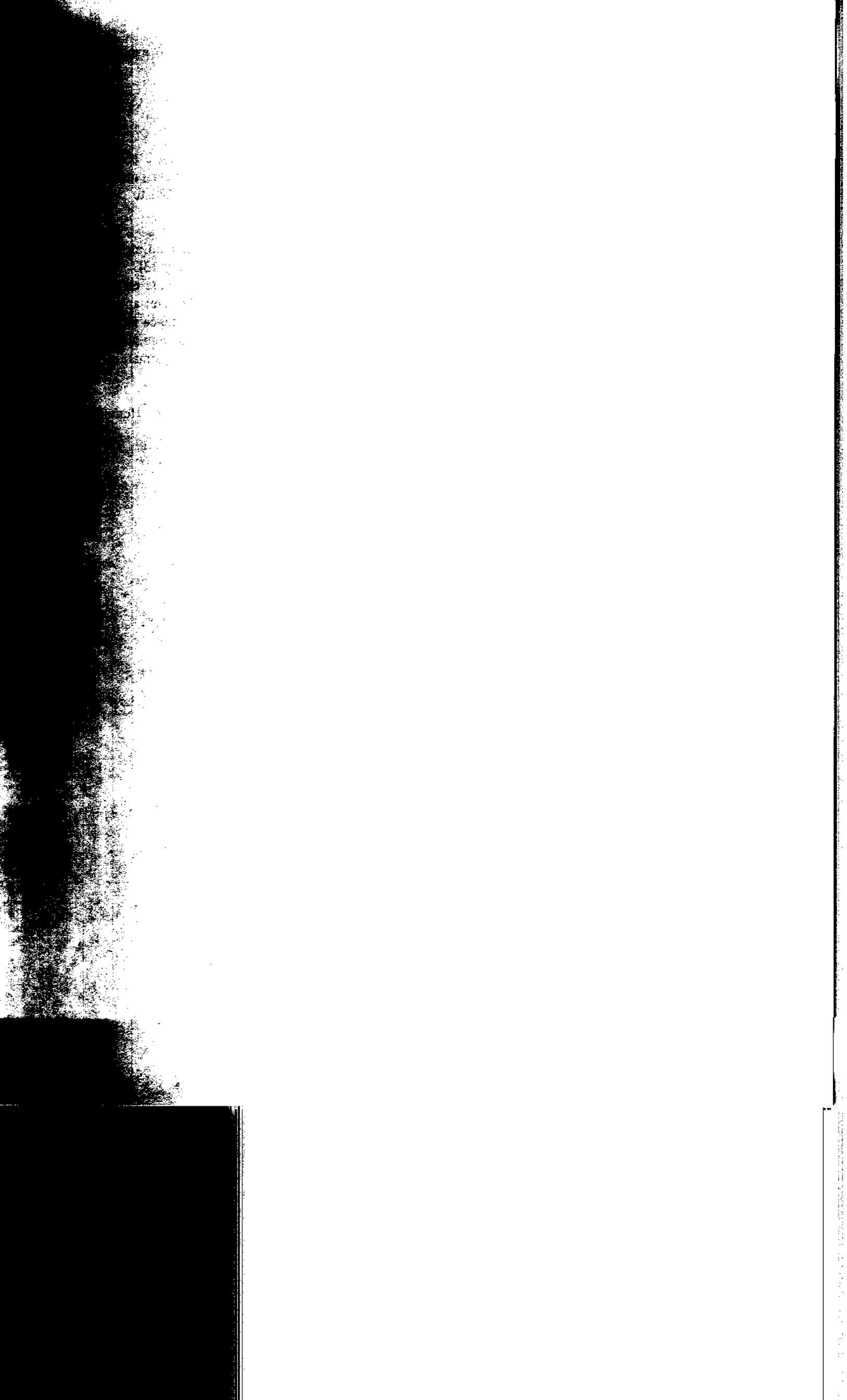
Probability Dis

Survey Param

The Federal Aviation Administration
video landing parameters were typical landing contact points for aircraft design criteria.

The initial landing parameter survey was conducted in June 1994. Four video cameras recorded images of 614 transport aircraft landings. The images were analyzed, and the results included approach speed; touchdown pitch attitude; and the position of the runway threshold. With the exception of the first 100 landings, the data were collected for most landings. Sixty percent of the data were processed and analyzed.

Subsequent surveys were conducted at the International runway 81/23 in 1995.



1. INTRODUCTION

In an effort to better jet transport aircraft Hughes Technical C activity commercial wide variety of aircraft gear and support structures valuable resource in

The use of image data aircraft were introduced landing environment safer. The Navy developed tracking and analysis developed in 1947 [1] developed a similar commercial airplanes systems was that the NASA's camera was runway center line.

In 1967, the Navy er This provided consta Using these systems, carrier landing survey intensive and limited improved system w implemented a system. The performance and thereafter, the Federal agreement to transitio

Preliminary results fr FAA Airports Conference [14], and

The FAA landing pa typical transport oper derived from usage of typical transport airp is a trend towards high

The first commercia International Airport /

NASA survey
stated that the
in the

documents
report. The c

images of aircraft
installed on
order, process
meter info

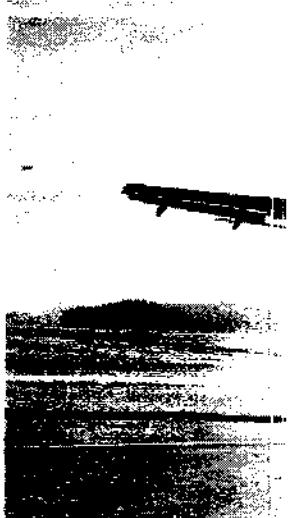
primary goa
ity of individ
report. Ai
model, type,

SYSTEM DESCRIPTION

developments
data analysi
video system is
NAALDAS.

wander, and a
video camera
(CATS) permit
is supported by
features (landin
and this info
information of camera
times to be determin
activity's previously

AS was design
camera. To
ment of a mo
located along
as the air
system coverage area
activity. Fiber-optic s
and the record
in February 199
(ACY), New J



**FIGURE 1. VIDEO
PAR.**

The video cameras are mounted on the aircraft. The cameras record the runway, and usually International Airport as the center of the target aircraft. Figure 2 is a



ge

F(t)

DAS video
sets which
operations, and
to generate

DAS data r
own region
o prevent any
away center
ns in the
electrical
relocatio
nt be prec
nsed.

image is c
analysis sy
number is
The use of v

segment an
this provide
airplane lar
physical dim
s. The sof
speed, hori

basis station co
player, comp
the station op
By position
track that fea
by using
levels, image
ing (edge o
image, elimi
procedures use
to locate ima

image sequen
eding param
the change
generates p

The system demons
confirmed the ability
was not possible with
landings under instru
showed the versatility

In addition to the video
describing each landing,
geometric data to use
an estimate of the tou

3. DISCUSSION.

A total of 621 landings
of 506 jet transport aircraft
and seven landings of

The video landing survey
13L, a 150-foot-wide
historical landing runway
available. Once the survey
to changes in operating
frequently favored op
body jets landed on runways

During peak operating
Airport makes it necessary
parallel runways; these
primarily for takeoffs.
landing runway used
videoed during the survey
survey, runway 13L v
existed daily, thus it
indicate, resulted in some
right turn onto final approach
the landing parameter

The analysis of image
reported value of approach
to the center line of
summaries were used

Landing parameters for
commuter aircraft later
were also processed

stable prov
paramet
reach sp

TABLE 1. SU

Number of Events	S
3	S
98	S
9	S
80	S
16	S
61	S
7	S
35	S
51	S
99	S
12	S
12	S
30	S

primary c
transport
1. Commu
this survey.



FIGURE 3. AVERAGE SINK SPEED FOR JET TRAINING AIRCRAFT

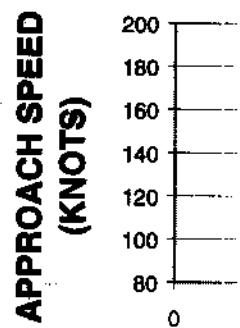


FIGURE 4. APPROXIMATE APPROACH SPEED FOR JET TRAINING AIRCRAFT

An unexpected number of Navy routinely observe approach speeds which were anticipated that an even distribution of this survey have ideal approach speeds of 1 ft/sec and 6 landings with approach speeds of 2 ft/sec. The military specification for approach speed occurs once every two landings.

it is apparent that aircraft uses with standard jets at different speeds distributed

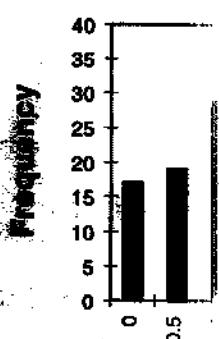
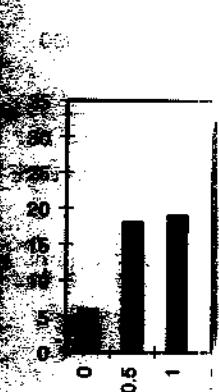


FIGURE 5. HISTOGRAMS

observed sink speed distributions no equivalent compensated usage of the probability that an aircraft specifications are identical

computer, narrow-bod
t the observed sink
ilitary design specific

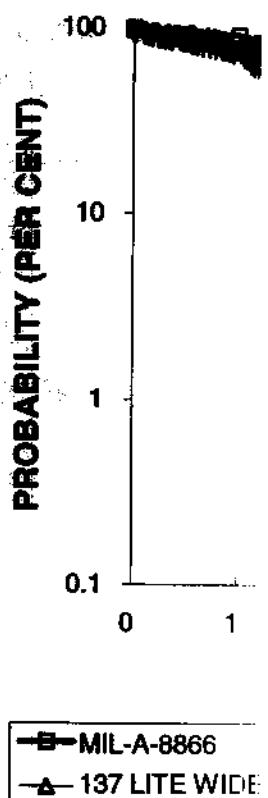


FIGURE 6. PROBABILITIES OF SINKAGE DURING SURVEY

The fact that the commercial aircraft may have influenced the choice of the runway are likely not representative of runways normally used on the landing parameter survey.

Statistical information for the survey are provided in appendix C. The landing, including commercial aircraft, parameter survey defines the range of parameters used in the survey. Appendix D contains the analysis of the survey results. Appendix E contains the configuration of the camera and the survey.

LANDING REQUIREMENTS

was the initial
t design and
this survey an-

g landing da-
ing large q

er limited nu-
l, and DC 10 i
must be collec-

data collected fo
the category of a
raft in the land-

REFERENCES.

1. Naval Air Dev't
NAES Photogr.
During Landing
2. NACA-TN-305
Immediately Pr
3. NASA Rep. 12
Airplane Landi
4. NASA, Jewel &
Aircraft, 1958,
5. NASA TN D-5
Turbojet Transp
Landings (Jet).
6. NASA TN-D-8
Turbojet Transp
May 1961, 100
7. FAA Flight Sta
for Jet Transport
8. Naval Air Dev't
Photographic M
Field or Carrier
9. Naval Air Warf
60, Naval Airc
Landing System
10. Naval Air Warf
60, Naval Airc
Landing System
11. DOT/FAA/CT-
Landing Param
12. Barnes, Terence
Impact Criteria,
Symposium, M

ore, Thomas
ing Survey
sions," FA

es, Terrenc
ing Paramet
Safety Inves

chlos, Richard
"raft," The 1
ember 1995

es of Federal
Transport Categ

APPENDIX A--ST

TOE-IN

TOE-OUT

TOE-IN/OUT

PARAMETER

Speed

Wheel

Front Wheel

Average of Main W

Speed

Speed to Camera)

Ground Speed

Speed

Parallel Component

Perpendicular Comp

Angle at Touchdown

Rate at Touchdown

PARAMETER

Speed

Angle

Main Wheel

Angle of Main W

Height

to Camera)

Speed

Angle

Component

Vertical Comp

Angle at Touchdow

Angle at Touchdow

Angle at Touchdow

Angle at Touchdown

Angle at Touchdow

Glide Slope /

From Touchdow

Threshold

Distance at

Angle

Reported Landin

DIAMETER

Speed

Speed

Wheel

of Main Whee

Camera)

Speed

Speed

l-Component

ular Compon

Touchdown

Touchdown

at Touchdown

Touchdown

at Touchdown

Side Slope Ang

on Touchdown

Threshold

Distance at

W

ported Landing

JC

METER

Wheel

of Main Whe

Camera)

ed

Component

lar Compone

Touchdown

Touchdown

Touchdown

Touchdown

Touchdown

at Touchdown

Glide Slope Ang

an Touchdown

eshold

Distance at

anted Landing

ANEMOMETER

Wind

Wind

Wind Wheel

Wind of Main Whe

(Camera)

Wind

Wind

Wind Component

Wind Component

Wind at Touchdown

Glide-Slope An

Wind Touchdown

Wind threshold

Wind resistance at

Wind at Selected Landing

Diameter
[redacted]
Wheel
of Main Whe
Camera)
[redacted]
[redacted]
Component
olar Compone
Touchdown
Touchdown
at Touchdown
at Touchdown
at Touchdown
Glide Slope Ang
From Touchdown
Threshold
Distance at
Reported Landing

PARAMETER

Speed

Height

Front Wheel

Height of Main Whe

Speed

to Camera)

Speed

Speed

Vertical Component

Angular ComponHeight at TouchdownHeight at TouchdownHeight at TouchdownHeight at TouchdownHeight at TouchdownHeight at TouchdownGlide Slope AnHeight at Touchdown

Threshold

Distance at

Height at Soft Landing

PARAMETER

Speed

Steer

Steering Wheel

Speed of Main Wheel

Speed Camera

Speed

Speed

Component

Angular Component

at Touchdown

Glide Slope Angle

From Touchdown

Threshold

Vertical Distance at

Touchdown

Reported Landing

PARAMETERSpeedSpeedMain WheelAlt. of Main WheSpeedAlt. Camera)SpeedSpeedComponentVertical ComponAlt. at TouchdownAlt. at TouchdownAlt. at TouchdownAlt. at TouchdownAlt. at TouchdownGlide Slope AngAlt. from TouchdowThresholdAlt. Distance atAlt. at Reported Landing

ALTIMETER012 Wheel3 of Main Whe4 Camera)5 ed67 Component8 Singular Compon9 at Touchdown0 Touchdown1 at Touchdown2 Touchdown3 at Touchdown4 Glide Slope An5 in Touchdow6 shold7 Distance at8 atted Landing

PARAMETER

Speed

Wheel

Front Wheel

Size of Main W

Speed

(to Camera)

Speed

Speed

Vertical Component

Vertical Compo

Angle at Touchdov

Angle at Touchdow

Angle at Touchdov

Angle at Touchdown

Angle at Touchdow

Glide Slope /

Min Touchdo

threshold

Distance at

Distance at

Accepted Landin

J

All

DIMMETER

ed

nel

nd Wheel

of Main Wh

(Camera)

nd

g

l Component

ular Compon

at Touchdow

Touchdown

at Touchdow

Touchdown

at Touchdow

ide Slope At

Touchdow

reshold

Distance at

n

ported Landin

EX B - LINEAR MODEL, FA

LNDG NO.	POWER APPROACH	CLOSURE SPEED	SINKING SPEED AT TOUCHDOWN		RAMP TO TD DIST	TD DIST FT	WEIGHT LBS	GLOBE SLOPE	PITCH ANGLE	ROLL RATE TD	ROLL ANGLE TD	PITCH RATE TD	YAW ANGLE TD	HEAD WIND AT TD	CROSS WIND AT TD	KNOTS AT TD
			PORT FT/SEC	STBD FT/SEC												
91	135	127	1.7	2.1	2.3	263900	2050	-3	0.6	5.8	3.6	0.0	-4.8	-6.2	8	3

LNDG NO.	POWER APPROACH	SINKING RATE			ROLL			PITCH			YAW			ROTATIONAL	
		CLOSURE SPEED	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS	RAMP TO TD DIST FT	TD OFF- CENTER FEET	ROLL ANGLE TD	PITCH ANGLE TD	ROLL RATE DEG/SEC	PITCH RATE DEG/SEC	YAW RATE DEG/SEC	KNOTS TD	TOUCHDOWN
290	151	146	2.8	1.1	2.0	244490	1571	.9	.5	.8.0	-1.1	.1	.1	10.0	5

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KNOTS	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS	AMP TO ID DIST FT	CENTER FEET	ID DEGREE	ID DEGREE SEC	ID DEGREE SEC	ID DEGREE SEC	LATE	EARLY	TOOK	TOTAL TIME
13	146	137	3.7	3.6	3.7	113206	1671	-16	0.9	6.4	-1.5	0.0	-3.1	-2.0	9	3
17	132	123	2.4	2.3	2.3	130244	1858	-3	0.6	5.7	-1.5	0.8	-3.0	9	3	3
23	125	116	4.0	2.3	3.1	2240	211	-2	0.9	6.0	0.1	-1.1	-2.7	9	3	3
27	125	116	4.0	2.3	3.1	211	211	-2	0.9	6.0	0.1	-1.1	-2.7	9	3	3

THE JOURNAL OF CLIMATE

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	TURBULENCE			RAMP TO RUNWAY OFF- CENTER FEET	TD-DIST FT	TD DEGREE										
			PORT FT/SEC	STBD FT/SEC	Avg FT/SEC													
514	145	136	2.2	1.1	1.4	141102	1905	1	0.3	6.4	-2.0	2.4	11.8	-4.3	9	16		
522	132	130	0.2	1.7	0.9	142192	1723	19	0.2	5.5	-0.9	3.9	-3.4	2	12			
524	140	138	2.6	2.3	2.1	142021	2126	13	0.5	6.2	0.1	3.2	-3.6	2	12			

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED		STBD PORT FT/SEC	AVG FT/SEC	WEIGHT LBS	RAMP TO RUNWAY OFF. CENTER FEET	ROLL RATE TD DEGREE SEC	PITCH RATE TD DEGREE SEC	YAW RATE TD DEGREE SEC	ROLL ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	YAW ANGLE TD DEGREE	ROLL RATE TD DEGREE SEC	PITCH RATE TD DEGREE SEC	YAW RATE TD DEGREE SEC	ROLL ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	YAW ANGLE TD DEGREE	ROLL RATE TD DEGREE SEC	PITCH RATE TD DEGREE SEC	YAW RATE TD DEGREE SEC	ROLL ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	YAW ANGLE TD DEGREE	ROLL RATE TD DEGREE SEC	PITCH RATE TD DEGREE SEC	YAW RATE TD DEGREE SEC	ROLL ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	YAW ANGLE TD DEGREE
		145	142	0.6	0.9	0.8	143321	2341	0.2	2.1	1.1	-2.0	-2.2	-3.4	3	8															
880	145	142	0.6	0.9	0.8	143321	2341	-3	0.2	2.1	1.1	-2.0	-2.2	-3.4	3	8															
887	134	132	0.8	1.0	0.9	142211	2352	-7	0.2	3.9	-1.1	1.2	-1.8	-1.0	1	7															
897	125	123	5.4	5.1	5.3	142211	910	-1	1.5	6.6	-2.1	0.8	6.9	-3.3	1	7															

TABLE 1
FAA SURVEY

LNDG NO.	POWER APPROACH SPEED KNOTS	CLOSURE SPEED KNOTS	SINKING SPEED AT TOUCHDOWN			RAMP TO TD DIST FT	WEIGHT LBS	RUNWAY OFF-CENTER FEET	ROLL ANGLE TD DEGREE	PITCH RATE TD DEG/SEC	ROLL RATE TD DEG/SEC	YAW ANGLE TD DEGREE	WIND KNOTS AT TOUCHDOWN
			PORT FT/SEC	STBD FT/SEC	Avg FT/SEC								
2	133	124	0.7	1.6	1.1	102300	2391	-10	0.3	6.5	0.1	1.0	0.8
69	138	128	1.7	1.5	1.7	165360	346	3	0.4	4.4	-1.6	1.3	8.8

LANDING DATA - MILE 1.75
FAA SURVEY JOHN F. KENNEDY INTERNATIONAL AIRPORT

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	SINKING SPEED AT TOUCHDOWN			WEIGHT LBS	RAMP TO TD DIST FT	RUNWAY OFF-CENTER FEET	GLIDE SLOPE ANGLE TD	PITCH ANGLE TD	ROLL RATE TD DEG/SEC	PITCH RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	YAW ANGLE TD DEGREE	HEAD WIND KNOTS AT TOUCHDOWN	CROSS-WIND KNOTS AT TOUCHDOWN
		CLOSURE SPEED KN	PORT FT/SEC	Avg FT/SEC											
27	141	132	1.7	4.9	4.5	503124	1524	.7	1.2	4.7	-1.0	-6.9	2.0	9	3

LANDG. NO.	SINGLE ENGINE			TWIN ENGINE			RUNWAY			SINGLE ENGINE			TWIN ENGINE		
	POWER	CLOSURE	TO GND DOWN	STBD	PORT	Avg	RAMP TO	TD DIST	RUNWAY OFF-CENTER	PITCH ANGLE	PITCH ANGLE	ROLL RATE	ROLL ANGLE	YAW RATE	YAW ANGLE
	APPROACH	SPEED	FT/SEC	FT/SEC	FT/SEC	FT/SEC	LBS	FT	TD FEET	TD	TD	DEG/SEC	TD	TD	KNOTS
875	150	149	3.9	3.0	3.5	3.5	900	2	0.8	4.0	-0.6	1.0	1.2	0.4	1
876	150	149	3.9	3.0	3.5	3.5	900	2	0.8	4.0	-0.6	1.0	1.2	0.4	1

LNDG NO.	SIMULATED AT TOUCHDOWN						WEIGHT LBS	RAMP TO TD DIST FT	RUNWAY SLOPE OFF CENTER FEET	PITCH ANGLE TD DEGREE	ROLL ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	PITCH RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	YAW ANGLE TD DEGREE	WIND KNOTS AT TOUCHDOWN	WIND KNOTS AT TOUCHDOWN
	POWER	APPROACH AIRSPD KNOTS	CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC											
10	116	107	1.9	3.4	2.8	2.8	828	-5	0.9	6.9	-1.2	1.5	-8.4	1.7	9	11	3

POWER APPROACH AIRSPEED		CLOSURE SPEED		PORT		STBD		RAMP TO TD DIST		RUNWAY OFF CENTER FEET		ROLL ANGLE TD		PITCH ANGLE TD		ROLL RATE TD		PITCH RATE TD		YAW ANGLE TD		ROLL RATE TD		PITCH RATE TD		YAW ANGLE TD	
LNDG NO.	KNOTS	KN	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT/SEC	FT	DEGREE	DEGREE	DEGREE	DEGREE	DEGREE	DEGREE	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC	DEG/SEC		
513	139	130	4.1	4.6	4.3	179900	719	7	1.1	4.5	3.1	4.9	-1.7	3.5	0.1	0.7	0.7	0.7	3.5	-3.6	-0.1	9	16	2	12		
523	137	135	4.1	4.6	4.3	182500	1758	3	0.3	4.6	0.6	4.6	-1.7	3.5	0.1	0.7	0.7	0.7	3.5	-3.6	-0.1	9	16	2	12		

AIA SURVEY REPORT

LNDG NO.	SINKING RATE			RUNWAY			ROLL			ROLL			WIND				
	POWER APPROACH KNOTS	CLOSURE SPEED KN	TOUCHDOWN FT/SEC	PORT STBD FT/SEC	Avg FT/SEC	WEIGHT LBS	RAMP TO TD DIST FT	OFF CENTER FEET	PITCH RATE TD	PITCH ANGLE TD	PITCH RATE TD	PITCH ANGLE TD	ROLL RATE DEG/SEC	ROLL ANGLE DEGREE	ROLL RATE TD	ROLL ANGLE TD	WIND KNOTS AT
14	131	122	3.8	1.8	2.2	287300	1498	5	0.6	8.7	8.9	3.8	-2.0	-4.7	9	3	3
18	142	132	3.1	1.7	1.9	272778	670	1	0.7	1.0	0.0	n.r.	1.0	1.0	0	0	0

		SPINNING SPEED AT TOUCHDOWN			RAMP TO TD DIST			RUNWAY OFF-CENTER FEET			PITCH ANGLE TD			ROLL ANGLE TD			YAW ANGLE TD		
LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	STBD PORT FT/SEC	STBD AVG FT/SEC	WEIGHT LBS	TD	FT	TD	DEGREE	DEGREE	DEG/SEC	TD	DEGREE	DEG/SEC	TD	DEGREE	DEG/SEC	TD	DEGREE
390	141	133	0.0	0.7	0.2	1.7	1.9	1.4	0.1	6.2	2.7	0.1	6.5	-1.4	0.1	6.4	2.3	-0.9	2.3
417	132	124	1.4	1.7	1.9	1.4	1.4	2.0	7	0.1	0.9	0.7	0.1	0.7	0.7	0.9	0.8	0.9	0.8

		NOTES	

LNDG NO.	SINKING SPEED AT TOUCHDOWN						RAMP TO TD DIST FT	RUNWAY OFF- CENTER FEET	GEAR SLOPE ANGLE TD DEGREE	PITCH RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	YAW ANGLE TD DEGREE	WIND KNOTS AT TOUCHDOWN
	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS								
817	161	156	0.3	0.2	0.1	26000	1849	8	0.0	3.6	0.7	0.2	2.5	-4.2
822	131	120	0.7	0.5	0.5	25400	1851	0	0.0	7.1	2.0	0.1	0.1	1.0

		SINKING SPEED AT TOUCHDOWN				RUNWAY SLIDE ANGLE OFF CENTER				PITCH ANGLE RATE				ROLL RATE		YAW ANGLE	
LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS	RAMP TO TD DIST FT	TD	TD	DEGREE	DEGREE	DEG/SEC	DEG/SEC	TD	TD	DEGREES AT TOUCHDOWN	KNOTS AT TOUCHDOWN
62	168	157	4.2	5.8	5.9	Not Recorded	831	-5	1.3	11.0	-2.1	-1.1	0.2	-0.9	10	4	
166	170	166	4.6	5.6	5.1	Recorded	410	.6	1.0	10.1	-2.6	1.4	-14.2	-2.6	3	9	

LANDING DATA
FAA SURVEY JOHN F. KENNEDY INT'L AIRPORT

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	SINKING SPEED AT TOUCHDOWN			WEIGHT LBS	RAMP TO TD DIST FT	RUNWAY OFF-CENTER FEET	GEDE SLOPE ANGLE TD	PITCH ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	PITCH RATE TD DEG/SEC	YAW ANGLE TD DEGREE	HEAD WIND KNOTS	CROSS WIND KNOTS	AT TOUCHDOWN
			STBD FT/SEC	PORT FT/SEC	Avg FT/SEC												
38	138	129	3.2	3.1	3.0	307840	2212	1	0.8	8.3	0.3	-0.1	1.4	-1.4	9	9	3

FAA SURVEY

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	SINKING SPEED AT TOUCHDOWN			RAMP TO TD DIST FT	RUNWAY OFF- CENTER FEET	GLIDE SLOPE ANGLE TD DEGREE	PITCH RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	YAW ANGLE TD DEGREE	TRUE WIND MILES AT TOUCHDOWN	TRUE WIND KNOTS
		CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS							
4	133	123	0.9	0.6	0.8	95300	811	-4	0.2	7.2	-1.2	-0.3	-4.7

FAA APPROVED APPROXIMATE LANDING DATA

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	SINKING SPEED AT TOUCHDOWN	GLIDE			ROLL RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	PITCH RATE TD DEG/SEC	PITCH ANGLE TD DEGREE	RUNWAY OFF CENTER FEET	RAMP TO TD DIST FT	WEIGHT LBS	AVG FT/SEC	STBD FT/SEC	PORT FT/SEC	
				SLOPE	ANGLE	TD											
126	132	126	132	1.6	1.0	1.3	31000	883	1	0.9	6.5	-2.0	1.5	0.2	1.9	6	10

FAA SURVEY JOURNAL NO. 107, JULY 1947

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	SINKING SPEED AT TOUCHDOWN			WEIGHT LBS	RAMP TO TD DIST	RUNWAY OFF- CENTER	CLIMB RATE TD	ROLL ANGLE TD	PITCH RATE TD	ROLL RATE TD	YAW ANGLE TD	HEAD WIND KNOTS	SIDE WIND KNOTS	TOUCHDOWN AT
		CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC											
53	131	120	0.9	1.0	0.9	101467	2430	2	0.3	4.6	0.6	1.8	-4.2	2.0	11
88	150	140	1.3	1.4	1.3	150000	2430	2	0.3	4.6	0.6	1.8	-4.2	2.0	11

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	TOUCHDOWN			RAMP TO TD DIST FT	RUNWAY OFF CENTER FEET	SLOPE ANGLE DEGREE	PITCH ANGLE DEGREE	ROLL RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	YAW RATE TD DEG/SEC	YAW ANGLE TD DEGREES	LANDING POSITION		
		CLOSURE SPEED KNOTS	PORT STBD FT/SEC	Avg FT/SEC	WEIGHT LBS	TD	TD	TD	TD	TD	TD	TD	TD	TD	TD
730	138	138	1.9	2.0	2.1	116099	818	3	0.5	3.6	0.0	1.1	-0.3	5.9	-1.9
734	131	131	1.8	2.0	2.1	116579	2359	5	0.6	3.9	0.0	1.1	-0.3	1.4	-1.7

LNDG NO.	POWER APPROACH	CLOSURE SPEED	TOUCHDOWN			RAMP TO TD DIST	RUNWAY SLOPE OFF- CENTER FEET	PITCH ANGLE TD	ROLL RATE TD	YAW ANGLE TD	WIND KNOTS AT TOUCHDOWN
			PORT FT/SEC	STBD FT/SEC	Avg FT/SEC						
28	101	92	2.1	1.6	1.9	32771	2397	-2	0.7	3.9	0.4
73	107	97	1.3	2.9	2.1	32771	2459	-4	0.7	2.9	0.7

LNDG NO.	POWER	SINKING RATE AT TOUCHDOWN			RAMP TO TD DIST	WEIGHT LBS	SLOPE ANGLE TD	PITCH ANGLE TD	ROLL RATE TD	VAN ANGLE TD	ENGINE ANGLE TD	TOUCHDOWN
		APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC						
9	77	67	67	0.3	0.9	0.6	1759	-6	0.3	6.3	-6.1	1.2
25	76	67	67	1.4	1.6	1.5	2140	1	0.7	3.9	1.9	-0.7

LNDG NO.	STATION 1000 FT. TOUCHDOWN						RAMP TO TD DIST FT	SLOPE ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	YAW RATE TD DEG/SEC	YAW ANGLE TD DEGREE	WIND KNOTS AT TOUCHDOWN
	POWER APPROACH AIRSPEED KNOTS	CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC	Avg FT/SEC	WEIGHT LBS								
3	74	65	0.0	0.6	0.3	1788	-1	0.2	6.7	-0.7	2.7	-1.0	9	3
171	122	117	2.9	4.5	4.0	688	-21	1.2	6.1	3.0	0.9	3.8	2.5	10

FAA

LNDG NO.	POWER APPROACH AIRSPEED KNOTS	SINKING SPEED AT TOUCHDOWN			WEIGHT LBS	RAMP TO TD DIST FT	RUNWAY SLOPE ANGLE TD DEGREE	PITCH ANGLE TD DEGREE	ROLL RATE TD DEG/SEC	ROLL ANGLE TD DEGREE	YAW ANGLE TD DEGREE	ROLL RATE AT TOUCHDOWN DEG/SEC	WIND SPEED AT TOUCHDOWN KNOTS
		CLOSURE SPEED KN	PORT FT/SEC	STBD FT/SEC									
8	116	106	1.6	2.6	2.3	22750	1735	4	0.7	3.6	-4.2	5.0	-5.8
55	122	112	1.1	1.3	1.2	23366	1273	3	0.4	5.0	-2.4	1.4	2.4

APPENDI

ΔV_v

ΔV_v is the sink speed required for a aircraft prior to landing gear is compressed determined

ΔV_v is sink speed required for a aircraft prior to landing gear is compressed determined

Symbol for aircraft sink speed

ΔV_w

ΔV_w is the wind speed the positive component of wind speed

Symbol for wind speed

CLOSURE SPEED V_c

V_c is the closure speed is the speed parallel to the closure speed is

Symbol for closure speed

CH SPEED V

V is the speed of approach is the speed parallel to the ground with respect to air

Symbol for approach speed

PITCH ANGLE

The pitch angle is determined from positive values obtained from:

the pitch angle

ROLL ANGLE

The roll angle is determined from positive values obtained from:

the roll angle used for roll

PITCH RATE

The pitch rate is determined from the main wheel. Positive values are determined by:

the pitch rate used for this

ROLL RATE

The roll rate is determined from the main wheel. Positive values are determined by:

the roll rate used for this

OFF-CENTER

Off-center is the distance measured from the centerline to the runway. This value is positive. Positive values indicate the aircraft is off the center line.

The symbol for this quantity is:

FROM RU

angle between
from image

for this qua

INSTANT.

is determine
) and closure

$$\beta_v = \arctan\left(\frac{V_{v_i}}{V_C}\right)$$

A consistent set

for this qua

WEIGHT W

weight repo

symbol for this qua

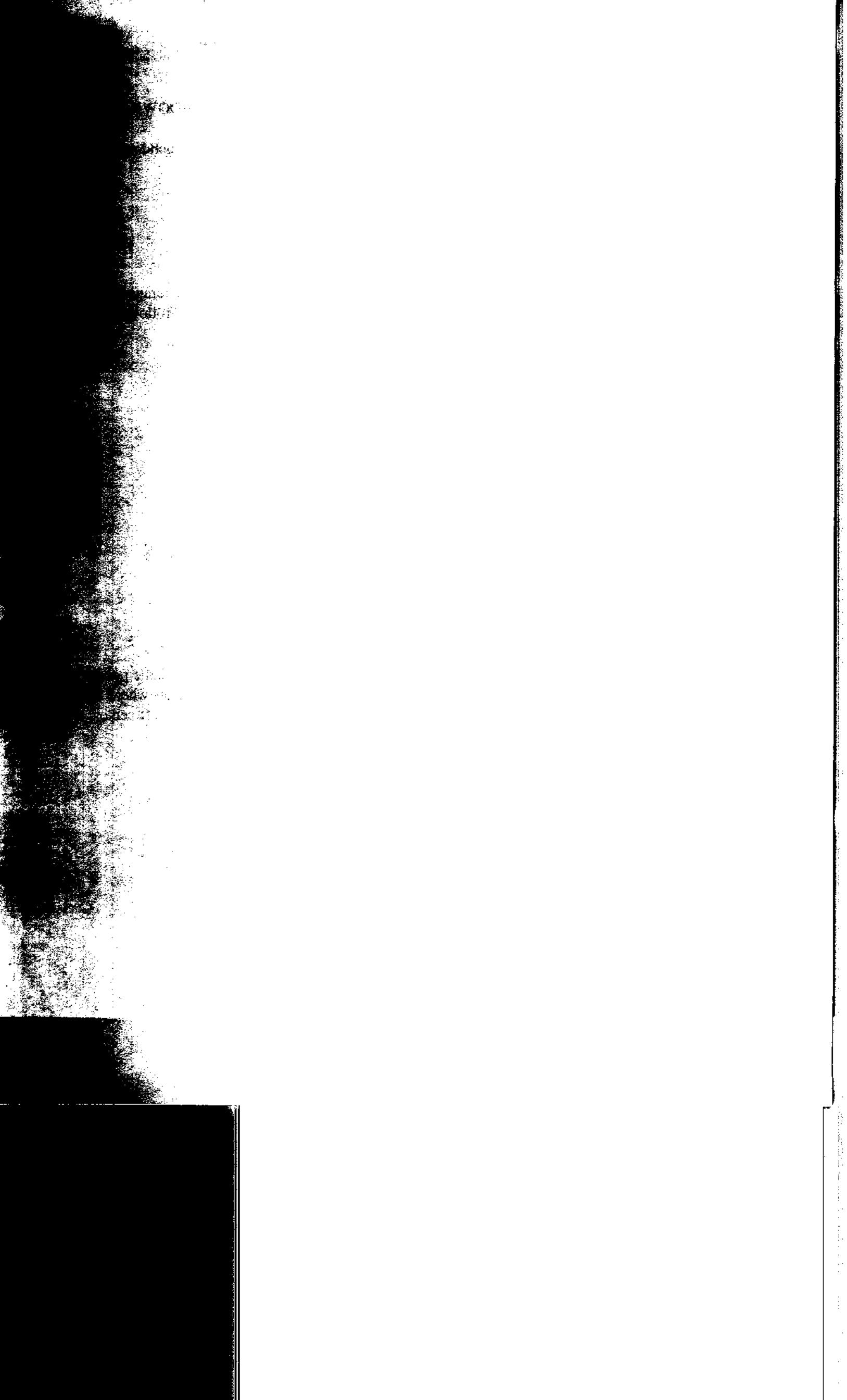
ET YAW ANC

angle is the ang
main wheel tou
rotation of the
ing a minimum ar

symbol for this qua

SUBSCRIPTS

P	-	Port
S	-	Starboard
N	-	Nose whe
A	-	Average
r	-	Roll
p	-	Pitch



APPENDIX D MEASUREMENTS

INTRODUCTION

uring parametric measurements (DAS), the system collects landing gear agreement data. Aircraft

uses a series of video landing gear system programs in a limited number of transports.

of the much larger was performed surveys. The Navy test of

leads to the analysis of the proper level of the system

DESCRIPTION

was designed to perform ground calibration and measure data at distance.

difficulty involved in system reconstruction and onboard processing in this test. In addition, some these diffi-

ALDAS system measures a known distance between landing gear via

the same size aircraft at a known height, position, and a

~~the sequence
was completed~~

~~re was repe-
tition. It was neces-
sary to increase the height. The
target flew over the target f-
or the range of this~~

~~part of the
own location
as are ex-
ception of a
stances and
image pi-
xel data is
a calibration.~~

~~NAALDAS
accuracy of
expected touch
the conflicting re-
testing was
had not be-
range from
resolution capa-
The land-based
expected touch~~

~~testing, the car
Airport were u-
testing. A sket-
as figure D-1.~~

~~maximum coverage
total distance
to the end of the
the first 500 feet
high concentrat-
camera three.
s are not sw-
the operating ca~~

FIGURE D-1

value for the
test was reported
as 5 ft/sec.
value used in
shutdown. In

test was reported
and 1000 feet

a very labor
for each fra
measured.

RESULTS

One-Hundred-Foot Test

D-2 is a plot of
measurements a
ession routin
le for this me
4.92 ft/sec. Th
of 0.5 ft/sec.

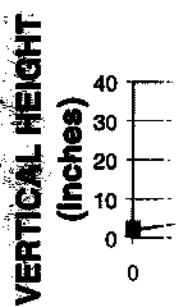


FIGURE D-2. N

One-Hundred-Foot Test

D-3 is a plot of
DAS determined
procedure provided a ve
0.47 ft/sec. The 98
accuracy for the system

assumed assumption
which is the tra

VERTICAL HEIGHT

FIGURE D-3. N

One Hundred-Foot Test

parts of the 800-
feet test used a sink rate
of 100 feet per second with confidence be-
cause no system is used. The c
ontractors were to meet an acc
ordance with National A
eronautics and Space Administration
guidelines only by p
roving the system. None of the s

VERTICAL HEIGHT
(Inches)

35
30
25
20
15
10
5
0

FIGURE D-4. N

One Thousand Foot Test

and smaller images to w
e and if our system a
ctually worked at JFK.

Two-Foot Test

the data at this level of the system in the two-foot test, no

CONCLUSIONS

The coverage and accurate measurement at acceptable levels is within 0.1 ft/0.03 m over 1000 foot from the target.

Results of these tests in the area during the flight limitation limits the range where the camera can

be used. Options used to increase the range and accuracy.

Actual surveying is difficult. This imposes a limit on the measurement. A speed of 130 knots is usually the result in the aircraft in consequence.

It would have been better if the capability had been tested with this technique, speeds, and an inc

reased precision needed to hit the target, it is appropriate to check out the accuracy over 1000 ft from the target.

None of the above factors affect the effective range of the statistical summation.